

Inclusive Competitiveness® at Temple Engineering

Keyanoush Sadeghipour, PhD
College of Engineering
Temple University
Philadelphia, USA

Jamie Bracey-Green, PhD
College of Engineering
Temple University
Philadelphia, USA

Abstract - In today's economy, institutions of higher learning play important roles in driving economic engines. Added to this are their responsibilities in creating social and environmental infrastructures in which everyone will thrive. Consequently, Temple Engineering's Center for Inclusive Competitiveness has developed a strategic plan to produce clearer opportunities for inclusive economic mobility through sustainability related industries across Pennsylvania. Pennsylvania's economy is lagging, in spite of extraordinary natural resources in energy, agriculture and health industries. Ranked #26 for economic growth and #43 for employment (USNews 2017), the Commonwealth is struggling to produce enough talent and entrepreneurs able to build technology enriched urban centers while simultaneously supporting strong rural agriculture across PA. Temple Engineering offers a bridge between rural and urban communities by tying economic growth to engineering infrastructure that improve social and humanitarian outcomes. This paper will present our strategies for engaging diverse faculty, students, community leaders, economic development experts and industry partners in our approach to engineering education for urban sustainability and social justice. The Center is expected to intensify recruitment and retention of students from urban community as partners.

I. INTRODUCTION

Temple University's College of Engineering is located in Philadelphia, Pennsylvania, a 330-year-old World Heritage City internationally recognized as the birthplace of American democracy. Philadelphia is the 5th largest metropolitan area in the United States, and even with its historic lineage, economists cite Philadelphia as the poorest big city in the nation with chronic and persistent poverty [1]. For decades Engineering's building has co-existed with low-income public housing, in a North Philadelphia neighborhood that reflects historically struggling and impoverished communities where the majority of families are disproportionately cultural or linguistic minorities, 40% live in poverty, math and science

proficiency levels are routinely below 15%, and there are higher proximity related violent crimes.

Our engineering students attend classes less than eight blocks from a high school deemed, until 2015, one of America's "most dangerous high schools", and two blocks away from the George Washington Carver High School of Engineering & Science, a stellar magnet school that Temple helped launch in 1979 and continues to support. Ironically, each has a 90% or greater African American student population, but the student opportunities to enter STEM pathways for the innovation economy are vastly different.

This paper provides an overview of our college's efforts to 1) transform our institutional culture to broaden the participation and success of the traditional students who seek out our accredited engineering programs and 2) promote an engineering mindset for problem solving, mentoring and entrepreneurship between our primarily white and Asian college students and industry experts, and the predominantly minority, disadvantaged STEM students learning about engineering careers related to urban sustainability and infrastructure.

II. Context

The complexity of climate change includes social and economic constraints that disproportionately impact majority minority communities lacking STEM skills required to recover quickly. In that vein, according to the 2010 US census, Philadelphia's racial composition is minority with a combined total of African American (43%) and non-white Hispanic/Latino residents (12%), 41% white (non-Hispanic) and less than 4% combined Asian, native American, etc. There has been an increase of about 113,000 immigrants between 2000 and 2006, which means immigrants now account for almost 11% of Philadelphia's population [2]. Because the Mayor of the City has

proclaimed Philadelphia a “sanctuary city” for prospective new Americans, that percentage is expected to grow. There is a fairly even age distribution with 35.8% of Philadelphians under age 25, 28.5% were 25 to 44, 23.5% were 45 to 64 and 12.1% were pre-retirement age of 65 or older, with a median age of 33.5 years [3]. The college’s targeted outreach community is classified as an economic development zone targeted for continuous urban renewal and recently received a \$30M choice neighborhood grant from the US Department of Housing and Urban Development agency. The funds are invested in neighborhoods of extreme poverty to transform them into functioning, sustainable mixed-income communities [4].

Traditional correlations between low socio-economic status and STEM aptitude and interest have turned most engineering schools away from students from poor districts, given chronically poor math and science performance from large under resourced districts like Philadelphia. This urban school district directly serves more than 220,000 children in public, charter, archdiocese, cyber and alternative education. Approximately 70% of the students are minority children, and the entire district is federally designated Title I by the US Department of Education, meaning the entire district is on the lowest rung of the federal poverty guidelines. Fortunately, progress is being made as the city has rallied to improve its student graduation rate from 55% to 67% in the past decade, with the Career and Technical Education (CTE) programs outpacing national norms with an 86% graduation rate.

Although the district lacks the capacity to track post-secondary entry into specific college degrees, data from external evaluations suggest *less than 5% of district students express confidence and interest in pursuing rigorous post-secondary STEM degrees*. It’s believed the vast majority of Philadelphia students are pursuing human service careers (retail, hospitality, criminal justice, social work, financial services, healthcare, etc.). The misalignment between minority students’ college aspirations and the talent needs of the innovation economy is a trap that threatens inclusive economic prosperity.

III. Temple’s focus on broadening participation

Starting in 2011, our college’s multi-year investment in middle and high school engineering education has served over 4,000 K-12 children across Philadelphia by providing critically needed access to STEM 1.0 (workshops, special events, tutoring, field trips, competitions, speakers and undergraduate peer mentors). By filling the significant gap in the district’s capacity to go beyond remediation and inspire participation in both engineering, technology and computer science programs, Temple Engineering has garnered local, state and international recognition for producing award winning students through its Mathematics, Engineering & Science Achievement (MESA USA) K-12 initiative.

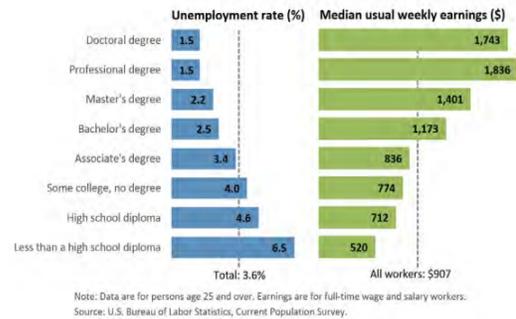
A strong network of school principals, teachers, counselors, parents and funders have enabled Temple Engineering to successfully offer rigorous afterschool programs. Engineering undergraduates mentor and coach middle and high school MESA students in identifying, designing and testing prototypes for solving food, energy and water related issues in urban settings. Dynamic assessments measure the change in minority pre-college students’ engineering mindset and interest in sustainability careers like environmental, civil and engineering technology. Pre- and post-assessment of engineering curricula complements performance related outcomes demonstrated through design and pitch competitions. Industry experts in water, micro-energy and civil infrastructure mentor Temple sponsored MESA Saturday Academy students, who have been 90% minority, have matriculated as undergraduates at a rate of 85% versus the state average of 71%, and of those who have entered college from the first middle school cohort, 70% have selected a variety of STEM degrees connected to the innovation economy - engineering, computer science, and technologies. MESA students have been recognized for competitive coding by the US Conference of Mayors, founded three technology companies before graduating college, created a community based organization to offer tech pre-apprenticeships, founded a venture capital company, served as mentors to MESA schools as undergraduates, and actively supported the founding

of computer science coding school in Delaware funded via a \$3M grant from JP Morgan foundation targeting unemployed and underemployed young adults.

IV. Developing the Eco-System to sustain and grow diversity

Temple Engineering has taken both an internal and external approach to supporting inclusive economic mobility. Distributing engineering education as a social justice activity begins with improving the quality of the learning experience of teachers. K-12 engineering and computer science curricula has been developed by the college and approved for use across Pennsylvania by the State Department of Education. In 2013 Temple Engineering became one of the first engineering schools in the United States to award K-12 teachers certification renewal credits. Faculty advisors helped develop modules, and engineering students were trained to provide the 2018 cohort of teacher training to white female teachers, 100% of whom indicated a deeper understanding of human centered design, engineering design and sensors embedded in internet of thing applications. Through this training Engineering's STEM activity has also been directly involved in the spread of pre-college engineering education to schools and NGOs in Brazil, Belize, Nigeria, and Ghana, and recognized. The University's Office of International Affairs has recently awarded Engineering a grant to support a network of 7 universities across the bread basket of Northern Nigeria to strengthen engineering that, promotes discovery, technology improves efficiency, math heightens imagination, and engineering solves the basic infrastructure problems that can minimize the stress of scarcity that threatens peace on our planet. Through the MESA pre-college program, expert mentors communicated the social and financial benefits that STEM careers like engineering offer disadvantaged students in the new economy.

Unemployment rates and earnings by educational attainment, 2017



The complexity of poor education outcomes translates into an inability for community residents to creatively solve crumbling infrastructure, health disparities and access to technologies to transform and sustain disconnected communities. Inclusivity requires STEM experts who are based in distressed communities to become proactive, and to use institutional assets to help future engineers make the invisible world they walk by a very real, vibrant opportunity for practice, professionalism and compassion.

V. Changing Engineering's Institutional Culture to Support Diversity & Inclusion

A. Students

Temple Engineering's success recruiting underrepresented groups is reflected in improved matriculation from 2013-2017. The total numbers of diverse students are significantly less than those of traditionally enrolled white and Asian engineering students, but targeted pre-college outreach, mentoring, work study support and career counseling have yielded a 27% increase in African American student enrollment, 45% increase in Hispanic/Latino student enrollment and a net gain of one (1) Native American student for a 50% gain.

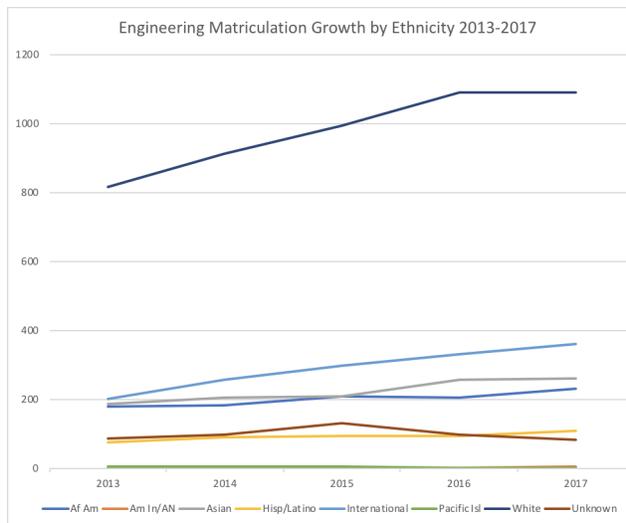


Chart 2. Growth in Temple Engineering student matriculations 2013-2017.

When the University lost funding for its dedicated student support services division in 2015, individual colleges developed internal strategies to support retention of students. In Engineering, the STEM center (now the Center for Inclusive Competitiveness) was assigned to identify and implement best practice retention activities. To begin, the center surveyed minority engineering students at Temple and Morgan State University to compare their motivation to persist (N=50; 83% African American). Temple’s undergraduates indicated affordability, school reputation, quality of the orientation and networking were primary factors while Morgan’s students prioritized networking, research opportunities, affordability and orientation. Across both campuses, underrepresented students reported having strong self-determination, strong responsibility to family, and the importance of college climate including faculty engagement as reasons to pursue engineering.

Based on the baseline data, and recommendations in the 2012 ASEE report “Going the Distance”, Temple initiated peer tutoring in the office of undergraduate advising, promoted faculty-led research internships and increased the number of on-campus corporate recruiting fairs. Engineering also secured funds from the NSF-funded Greater Philadelphia LSAMP program to support NSBE, SWE and SHPE students’ community STEM outreach and travel to their

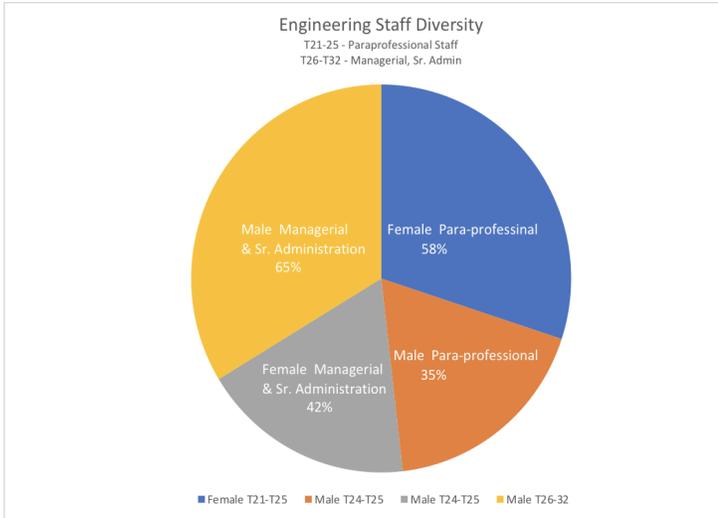
respective national engineering conferences. Since 2014, the STEM department has created and raised funds to sponsor up to 10 work study positions each semester to support the MESA K-12 program, thereby helping to address undergraduate affordability issues.

As a result, under the college’s umbrella, Temple’s award-winning National Society of Black Engineers [NSBE] student chapter has been recognized as “mid-sized chapter of the year” at that the national NSBE conference four times in last eight (8) years for its pre-college K-12 community activities. The 27% growth in Temple Engineering’s Society of Women Engineers [SWE] student chapter is one of the fastest growing organizations on campus, and the Society of Hispanic Professional Engineers [SHPE] student professional organizations as emerged, reflecting the 45% increase in Hispanic/Latino matriculations noted above.

B. Staff Diversity

The Engineering staff reflects 59% women and 41% men. The majority of staff are white males and females, followed by Asian males, Asian females, Hispanic males, African American women, African American males and Hispanic females. Engineering’s commitment to inclusive economic mobility is directly tied to the growth in student enrollments and tuition revenue.

Changes in financial strength have allowed the leadership team to provide improved career opportunities for women resulting in the creation of four senior management positions in the past five years including the Director of Research Administration, the Director of Strategic Communications, the Director of Enrollment Management and the Director of the Center for Inclusive Competitiveness, who also serves as the Director of STEM Education.



C. Faculty diversity growth 2013-2017

Engineering has tripled its female faculty representation from 5 in 2013 to 15 in 2017, which represents 25% of the total tenure and non-tenure track faculty in the college. Surprisingly, this mirrors the female diversity of our students in the college. The research portfolio associated with women faculty has increased by nearly 600% increase in research revenue from \$646,000 in 2015 to \$3.8M in 2018.

Overall, Temple Engineering’s leaders believe this improvement in diversity has created an environment that increases the institution’s ability to consider multiple perspectives about internal priorities, program offerings and retention strategies to advance peace and prosperity in underrepresented communities where we work and learn.

D. The Inclusive Growth Paradox

The data on America’s poor production of minority engineers illuminates the paradox former MIT President Charles Vest alluded to in a book about diversity in the profession:

...“it is about both triumph and failure. It is about the complexity of life and race...It simultaneously gives us hope, pride and inspiration, yet says how slowly many important things have changed. It displays the gap between where we are and where we ought to be in our quest for an inclusive, just society.” [5]

Producing engineers in large urban centers with the profile of a city like Philadelphia requires understanding the paradox of developing the engineering “problem solving” mindset among students least likely to have teachers prepared with content expertise in math and science. The poverty level of the city has undermined its ability to transform from its post-industrial past. But, efforts are underway to move to a tech enriched micro industrial future, focused on topics such as urban agriculture and food processing, water technologies and energy businesses - all reliant on STEM education and processes to provide living wage jobs.

Producing STEM talent with the ability to create and market solutions is the goal of Temple’s new Center for Inclusive Competitiveness, which has an internal and external mandate to advance inclusive economic mobility.

SOLUTION: The Center for Inclusive Competitiveness (CIC) is strategically deploying a new economic framework and a new community engagement system that leverages the strength of the College. The deliverables are a clear dual credit pathway to competitive STEM coursework pathways, retention of minority students through cohort activities, expert mentoring, and business start up support for community owned entrepreneurship through food cooperatives, in-door engineered growing environments, and micro manufacturing related to local and regional sustainability.

The internal work includes continued growth and scaling of engineering’s award-winning STEM outreach program, increased engagement and matriculation of underrepresented students from Philadelphia.

The Center’s external mandate includes identifying sustainability initiatives (social, economic and environmental) related to business development opportunities for students, faculty and community stakeholders. To date the Center has successfully initiated a historic collaboration with Temple’s schools of engineering, business, medicine, health professions, science and technology.

In addition, the Center has immediately engaged experts in city planning, commerce and community leadership to develop certificate programs for undergraduate and local residents in the one-mile radius surrounding the College of Engineering.

The Center's role in promoting and convening sustainability in poverty stricken North Philadelphia will be measured internally through student retention, empathy, altruism, and completion of design tasks related to urban sustainability.

Measuring institutional culture change will rely on

- 1) data from faculty, staff and leaders on consistency in community outreach activities started and completed inside the College with student organization support,
- 2) the number of dual credit courses generated for local high school teachers and students to accelerate student academic achievement in engineering disciplines related to sustainability, and
- 3) increases in faculty led collaborative research proposals that support broadening participation of pre-college and 1st year minority students in community transformations.

VI. Summary

Economic *inclusion* is traditionally thought of as an after-thought of bolted-on diversity, initiates targeting workforce development. *Competitiveness* targets business development, growth, productivity, infrastructure needs and outcomes that improve quality of life and sustained access to shared prosperity. Any approach to economic *inclusion* that fails to include *competitiveness* will ultimately result in maintaining the status quo of economic *segregation*, which produced this present-day unsustainable economic condition. Competitiveness is the key to developing new economic impact and job growth because it is an intentional **measurable evidence and metric-based approach** as a “think-and-do” tank that focuses on five core competencies:

- **DEVELOP STEM TALENT PIPELINE:**
 - The CIC will cultivate specialized high school workforce talent in

target areas of food tech, energy and water, leveraging the Pathways Project.

- **DEVELOP STEAM-POWERED ENTREPRENEURSHIP PIPELINE:**
 - The CIC will establish a semester-length interdisciplinary entrepreneurial immersion experience (EIE) to include a public hackathon.
 - The EIE will feed into an IC Business Incubator that will nurture promising engineering and STEM teams that emerge from the EIE.
 - The CIC Accelerator (complete with Demo Day Graduation) will produce market-driven scalable enterprises to a network of angel investors.
- **CONVENE THOUGHT LEADERS:**
 - The CIC will establish a branded quarterly series of convening leadership voices in the innovation economy.
 - The Center will coordinate and lead community engagement in the regional & global competitiveness strategies planning processes and serve as an active proponent for developing new infrastructure and access pathways to economic opportunity and share prosperity for disconnected communities of color.
- **RESEARCH & DEVELOPMENT OUTPUTS:**
 - The CIC will produce a branded Inclusive Competitiveness Index (ICI) with a Competitiveness Quotient (CQ) and an Inclusive Competitiveness Report (ICR).
 - The CIC will produce relevant data needed to inform elected leaders, policymakers, foundations, CEDS and regional competitiveness strategies planners about

productivity measures in
communities of color.

REFERENCES

- [1] Pew Charitable Trusts Philadelphia Research Initiative. Retrieved from <https://www.pewtrusts.org/en/research-and-analysis/articles/2017/11/15/philadelphias-poverty-rates-explained-in-five-charts>.
- [2] Pew Charitable Trusts Philadelphia Research Initiative. Retrieved from <https://www.pewtrusts.org/en/research-and-analysis/articles/2017/11/15/philadelphias-poverty-rates-explained-in-five-charts>.
- [3] <https://philly.curbed.com/2018/9/10/17841748/affordable-housing-apartment-rental-pha-hud-norris-temple>
- [4] US Census Bureau (2017). Retrieved from <https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF>
- [5] Williams, Charles (2001). *Technology and the Dream: Reflections on the Black Experience at MIT, 1941-1999*. MIT Press: Cambridge, MA.